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Fingering phenomena at high surfactant concentrations OMAR K. MATAR, RICHARD CRASTER, BARRY EDMONSTONE, Imperial College London — The spreading of a soluble surfactant droplet on a pre-existing thin liquid layer is considered at concentrations beyond the critical micelle concentration (CMC). Lubrication theory is used to derive a coupled system of four two-dimensional nonlinear evolution equations for the film thickness, monomer interface and bulk concentrations and micellar concentration. These equations are closed by a nonlinear surfactant equation of state. Our numerical results for the base state indicate that increasing the mass of surfactant deposited leads to the development of a protuberance that appears at the edge of the drop. For a sufficiently large mass, this feature separates from the drop to form a distinct secondary front that lies behind a leading front, which usually accompanies the spreading process. The results of our transient growth analysis and transient numerical simulations indicate that these features are vulnerable to transverse perturbations leading to the formation of fingers. The results obtained in the present work appear to capture phenomena recently observed experimentally.

Omar K. Matar
Imperial College London

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